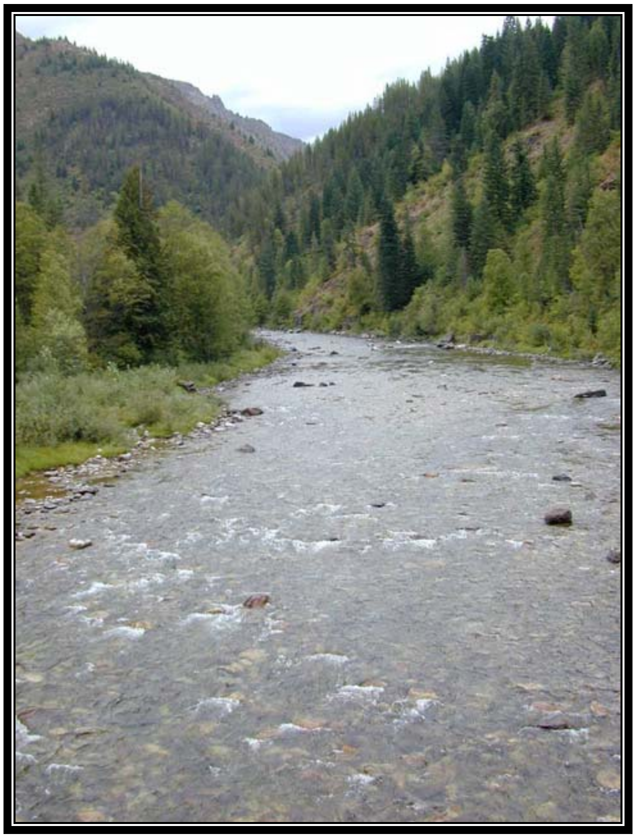
Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads



Department of Environmental Quality
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1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the Upper North Fork Clearwater Subbasin (UNFCRS) that have been placed on what is known as the "303(d) list."

The overall purpose of this subbasin assessment and TMDLs is to characterize and document pollutant loads within the UNFCRS. The first portion of this document, the subbasin assessment, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Chapters 1 – 4). This information is then summarized for each water body in Chapter 5 and used to develop TMDLs for each pollutant of concern for the UNFCRS in Chapter 6.

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (USEPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Idaho Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the USEPA oversees Idaho water pollution control activities and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with USEPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses. These requirements result in a list of impaired waters, called the "303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and subsequent TMDLs provide a summary of the water quality status and allowable TMDL for water bodies on the 303(d) list. This document, *Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads,* provides this summary for the currently listed waters in the UNFCRS.

The subbasin assessment section of this report (Chapters 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the UNFCRS to date. While this assessment is not a requirement of the TMDLs, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDLs are plans to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is water body and pollutant specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The USEPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutant as "pollution." TMDLs are not required for water bodies impaired by pollution but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include:

- Aquatic life use support – cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation – primary (swimming), secondary (boating)
- Water supply – domestic, agricultural, industrial
- Wildlife habitat, aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

A subbasin assessment entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).

- Determine the degree of achievement of biological integrity.

- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.

- When water bodies are not attaining water quality standards, determine the causes and extent of the impairment.

Methodology

This subbasin assessment for the UNFCRS examines the water quality for each of the 20 303(d) listed water bodies in the subbasin. They are assessed to determine whether or not their water quality meets the standards of Idaho State Code Section 58.01.02 (Water Quality Standards and Wastewater Treatment Requirements). If it is determined that the water quality does not meet the state's standards as the result of an identified pollutant, then a TMDL for that pollutant for that water body is developed. In addition, streams designated by the USEPA as protected for bull trout spawning and rearing are assessed using the USEPA temperature standards (40 CFR Part 131.33(a)), and if they do not meet the standards, a TMDL for temperature is developed.

This report describes the setting of the UNFCRS (Chapter 1), including physiographic, biological, and human cultural characteristics. Next, in Chapter 2, we discuss the applicable state and federal water quality standards in relation to the water pollution issues within the UNFCRS. The two major pollutants of concern are sediment and heat. Also in Chapter 2, we present the assessment techniques we have available to help determine the extent of the impact of the pollutants on water quality. The primary data sets and analyses are those contained in DEQ's Beneficial Use Reconnaissance Program (BURP) and its associated *1996 Water Body Assessment Guidance* (WBAG) (DEQ 1996). Additional data that relate to water quality are also identified in Chapter 2.

In Chapter 3, we discuss current knowledge about the sources and effects of the pollutants, past and current efforts to control the pollutants, and gaps in our knowledge base about the pollutants in the UNFCRS. In Chapter 4, we discuss efforts to improve water quality that have already been implemented. In Chapter 5, the data from Chapters 2, 3, and 4 are summarized water body–by-water body, and conclusions are drawn as to water quality status and the need for TMDLs. Finally, in Chapter 6, a loading analysis is completed and a TMDL is developed for each water body identified as water quality impaired in Chapter 5.

As an initial step in the UNFCRS assessment, we divided the Orogrande Creek stream segment into two water bodies. This division is consistent with Idaho's water quality standards wherein Orogrande Creek is divided into two water body units (IDAPA 58.01.02.120.09) even though, on the 303(d) list, the whole of Orogrande Creek is 303(d) listed for sediment. The upper part of Orogrande Creek, above the confluence with French Creek, is primarily managed by Potlatch Corporation and the Idaho Department of Lands (IDL). The lower part of the Orogrande Creek watershed and all the other listed watersheds in the UNFCRS are managed by the Clearwater National Forest (CNF). Data collected by the CNF are significantly different from those of the state and private forestland mangers. While 19 individual streams are being analyzed, the division of Orogrande Creek results in 20 stream segments being analyzed for water quality problems.

At the outset of this investigation, we discussed how to assess Sneak Creek, which is listed for channel stability. We assessed this stream specifically for channel stability as measured by percent of raw banks. In addition, since the most likely pollutant affecting beneficial uses as a result of channel instability would be sediment, we assessed Sneak Creek for sediment in the same manner as all the other sediment listed streams in the UNFCRS.

We first analyzed each of the 20 streams using DEQ's BURP data following the 1996 WBAG (DEQ 1996). The BURP procedure is a rapid assessment method of collecting data from one or a few representative sites within a water body. The WBAG specifies the procedures for analyzing that data to determine whether beneficial uses are being supported or not. The streams were assessed using BURP protocols in 1997 and 1998. In a process known as "WBAG plus," additional information about the water quality from various other sources was considered in relation to the WBAG results. A final water quality status determination was made based on the weight of evidence of whether a given pollutant exceeds state or federal water quality standards and is limiting the designated beneficial uses.

The first step in the WBAG process is to assess whether any numeric criteria are exceeded. In the case of water bodies in this subbasin, we know that temperature exceedances exist for most of the streams. Stream temperature data from the CNF were evaluated against the USEPA designated standards for bull trout protected streams and against Idaho water quality standards for other water bodies supporting other salmonids. Outside the bull trout protected water bodies, the other 303(d) streams, except Cougar, Grizzly, Deception, and Tumble Creeks, have populations of cutthroat trout, so they were evaluated against the cutthroat trout temperature standards. Tumble Creek supports only brook trout and was evaluated against that criterion.

It was determined that temperature standard exceedances occur in every 303(d) listed water body in this subbasin except Tumble Creek. Since most of the water bodies in the subbasin are listed for sediment, rather than temperature, we continued to follow the WBAG plus process to determine whether sediment is also limiting water quality beyond the state

standards. We conducted the sediment assessments as though the temperature exceedances did not exist.
For the sediment assessment in Chapter 3 we identified the major sources of sediment in the subbasin. We then considered the BURP data and WBAG conclusions in relation to other available data about potential sediment sources on a water body by water body basis.

In a geographic information systems (GIS) program we delineated the watershed surrounding each listed water body as the area for consideration, resulting in a sixth field hydrologic unit (HUC) delineation. We looked at the characteristics listed below as potentially impacting sediment loading. To a degree, these characteristics were chosen because similar types of data exist for them in both the CNF and the state of Idaho forest practices (IDL 2000) data sets. A high ranking for any given characteristic triggered further analysis in relation to the WBAG conclusion.

<u>Road Density</u>. We used either the Potlatch Corporation or CNF digital roads GIS layer to determine the number of miles of roads per square mile of the watershed. All things being equal, the higher the road density, the greater the potential for sediment being delivered to a stream. However, road design and maintenance can greatly influence this relationship.

<u>Mass Failures</u>. Potlatch Corporation, IDL, and the CNF collected extensive mass failure location data after the 1995-96 rain-on-snow events (McClelland et al. 1997). Since then, these data have been partially updated by the CNF and Cumulative Watershed Effects (CWE) assessments. The mass failure data were sorted by watershed in GIS. For each watershed, the total number of mass failures and the mass failure density is presented. These data are dated and many of the sites have been restored.

<u>Channel Stability</u>. The CNF has conducted bio-physical studies of most of the watersheds being assessed herein, the methodologies of which are discussed in Chapter 3. One of the indices developed is a bank stability index ranging from 0 to 5 based on the percentage of raw banks (0 indicates >50% raw banks and 5 indicates 0% raw banks).

The CWE process includes a channel stability assessment based on the Pfankuch method (Pfankuch 1978). In those watersheds where CWE data are available, the CWE channel stability scores are presented.

<u>Road Erosion</u>. The CNF uses the *Watershed Response Model for Forest Management* (WATBAL) to predict the amount of sediment being delivered in a watershed (Patten 1989). A background sediment delivery rate is calculated for each watershed based on the landtypes in the watershed. Then additional sediment delivery is calculated based on the lengths, types, and ages of roads; timber harvest; and other activities. A figure is generated for the amount of sediment being delivered over background amounts.

The CWE roads module assesses on the ground the amount of sediment being produced and delivered to a water channel. The CWE road sediment delivery scores are presented in Chapter 3. As part of this assessment, we conducted preliminary CWE road assessments as we visited the watersheds to compare to the WATBAL results.

<u>Roads Close to Streams</u>. Using GIS, a number was calculated for the number of miles of road in each 303(d) listed watershed that are within 100 feet of a stream. Proximity to a stream is only a *potential* sediment problem—many roads within 100 feet of a stream do not deliver any sediment to the stream channel.

<u>Roads in High Mass Failure Hazard Zones</u>. A number was calculated in GIS for the number of miles of road in each 303(d) listed watershed that are on landtypes with high or very high mass failure hazard ratings. Road design and maintenance greatly affect the potential impacts these roads might have.

<u>Logged Areas.</u> The CNF tree stand database was used to identify the total number of acres per watershed that have been entered for logging. No adjustment was made for partial canopy removal at the time of entry or for the canopy recovery since.

On state and private lands, a canopy removal index was generated using the CWE database. This is an estimate of current canopy condition in relation to the natural condition.

Generally, for the water bodies 303(d) listed as sediment impaired, the results were considered in light of any high-ranking potential sediment source characteristic. The final decision about any water quality impairment beyond the limits of the state standards, however, was largely driven by the beneficial use status of the water body. Specific to the water bodies in the UNFCRS, if it was clear that salmonid spawning as determined by the WBAG is occurring, then water quality is considered to be meeting the state standards.

For the assessment of channel stability impairment of Sneak Creek, we observed portions of the water body in the field and used the data from the CNF's *Habitat Conditions and Salmonid Abundance in the Sheep and Sneak Creek Drainages* (Clearwater BioStudies, Inc. 1995b) report for the stream.

The subbasin assessment resulted in one of two conclusions for each of the pollutants for each water body. If it was concluded that a water body is not impaired by the pollutant, then the proposal was made that the water body be removed from the 303(d) list for that pollutant. If it was concluded that a water body is indeed impaired by a pollutant, then a TMDL was developed for that water body and pollutant.

TMDLs were developed for 18 water bodies in the UNFCRS; these appear in Chapter 5. Temperature TMDLs were developed for 18 water bodies, and a sediment TMDL was developed for one water body (Deception Gulch). Of the 303(d) listed water bodies, only Tumble and Hem Creeks were found to be fully supporting their beneficial uses and do not have TMDLs developed for them.

For temperature TMDLs, we used the stream temperature to percent canopy closure and elevation relationship developed under the Idaho Forest Practices Act Cumulative Watershed Effects process (IDL 2000). The model estimates needed percent canopy closure to protect a stream for any selected maximum weekly maximum temperature (MWMT). The selected MWMT was the temperature standard for the species requiring the coldest water. For example, the percent stream canopy closure needed to protect stream temperatures for bull trout at a given elevation is greater than the percent stream canopy closure needed to protect temperatures for general salmonid spawning because bull trout water quality standards require colder water. The model is dependent on elevation and was run at 200-foot elevation intervals, resulting in the designation of 860 stream segments for which temperature loading analyses were run. The model-estimated percent canopy closure needed to protect stream temperatures was compared to existing percent canopy closure. If the model-estimated percent canopy closure needed to protect stream temperatures was greater than the existing percent canopy closure, a percent canopy closure target was set based on the model estimate, and a TMDL requiring increased shade was developed. If the model-estimated percent canopy closure needed to protect stream temperature was less than or equal to the existing percent canopy closure, then the existing percent canopy closure was set as the target. We identified stream segments throughout the 303(d)-listed watersheds that lacked adequate stream shading for the most temperature sensitive salmonid species and developed TMDLs for them on a stream segment by stream segment basis.

For the sediment TMDL, we used a sediment balance approach. We used a standard figure of 25 tons per square mile for background sediment developed by the CNF (Wilson et al. 1982). Significant additional sediment was considered to be coming only from roads and mass failures. We used a GIS coverage of mass failures coupled with an estimate of their size and percent delivery to calculate the amount of sediment being delivered from mass failures. We then used both the CWE road assessment module and the CNF WATBAL calculations to develop a figure for sediment being delivered from roads. For total allowable loading, we used a CNF-developed figure for the percent sediment delivery over background that would allow a viable population of salmonids (Jones and Murphy 1997). The targeted load is that amount over background that would still result in salmonid spawning. The targeted load reduction amount is allocated to roads in the watershed and calculations were made for the number of miles of roads that need to be obliterated to meet the TMDL targets.

1.2 Physical and Biological Characteristics

This section of the report summarizes the physical and biological characteristics of the UNFCRS. Extensive physical and biological data are available because the subbasin is almost entirely public land managed by the U.S. Department of Agriculture, Forest Service (USFS), Clearwater National Forest. This summary focuses on those data that are most useful to understanding threats to the subbasin's surface water quality.

The North Fork of the Clearwater River is located in north-central Idaho, running 130 miles from the divide on the Montana-Idaho border westward towards Orofino, Idaho. The UNFCRS is that portion of the North Fork of the Clearwater River watershed above the U.S. Geological Survey (USGS) gauging station immediately above the confluence of Beaver Creek with the North Fork Clearwater River. Within the USGS hydrologic unit classification system (Seaber et al. 1984), the UNFCRS is identified by the fourth order HUC 17060307. (The Lower North Fork Clearwater River Subbasin is the remainder of the watershed, most of which drains directly into Dworshak Reservoir and is identified as HUC 17060308.) The Upper North Fork Clearwater River (UNFCR) is a 75-mile long, eighth order water body (based on 1:24,000 scale hydrography), draining 1,294 square miles (828,000 acres). The vast majority of the UNFCRS is managed by the CNF, with much smaller areas managed by IDL, Potlatch Corporation, and small private owners. Figure 1 shows the UNFCRS, its ownership, the river, and major tributary streams.

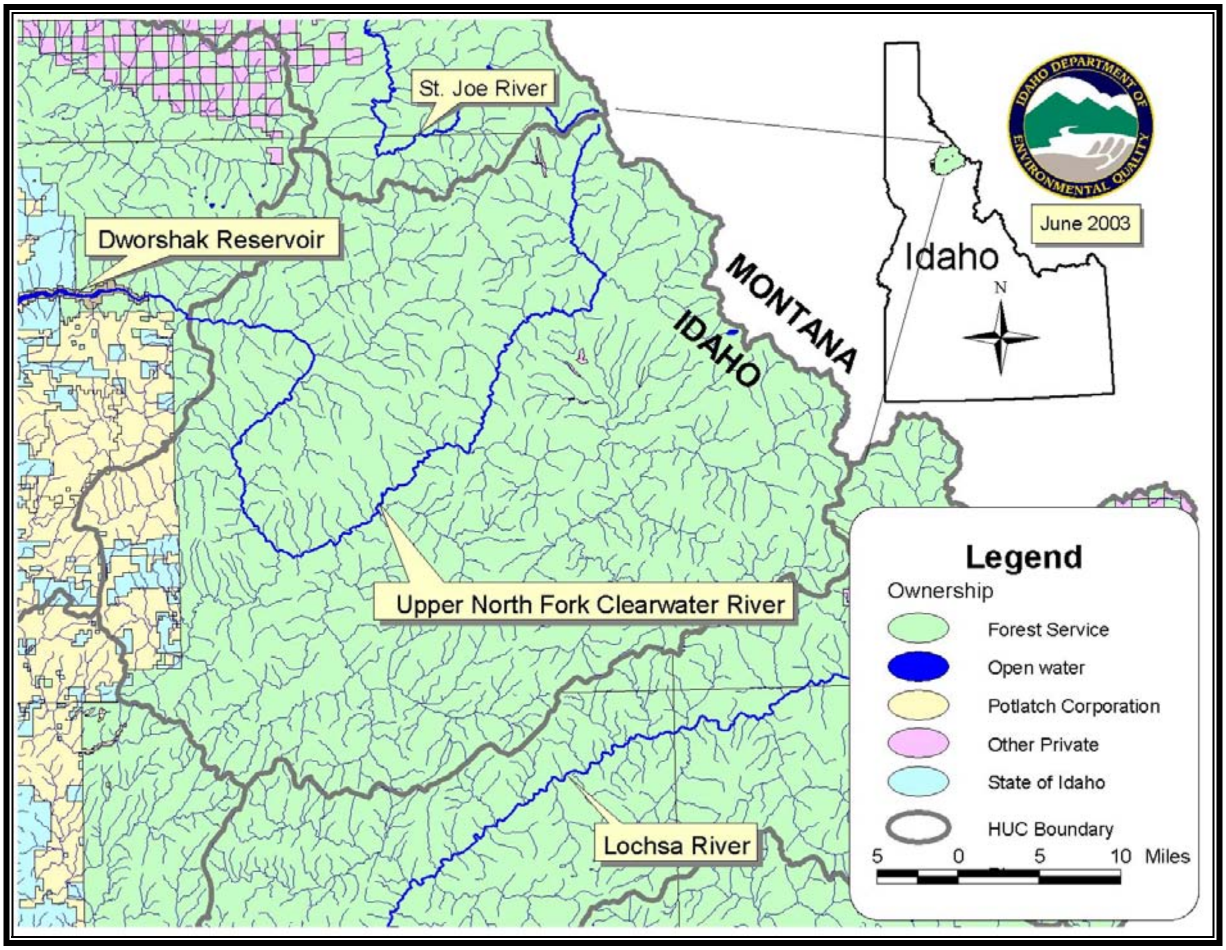

Figure 1. Location in Idaho and Ownership of the UNFCRS

Climate

North Idaho's climate is dominated by Pacific Ocean maritime air masses and prevailing westerly winds. Precipitation in the UNFCRS ranges from about 30 inches to over 70 inches per year (Figure 2), with over 90 percent of the annual precipitation occurring during the fall, winter, and spring months. Cyclonic storms consisting of a series of frontal systems moving west to east produce long duration, low intensity precipitation from fall through spring. A seasonal snowpack generally covers the area from November to May. High intensity electric storms occur during the summer months, frequently causing wildfires.

At lower elevations, along the mainstem UNFCR, the subbasin climate has mild wet winters and hot dry summers. At elevations above about 4,000 feet, most of the winter precipitation falls as snow. The winter snowpack water content usually peaks in early April and snowmelt contributes much of the summer stream flow. Generally, there is very little precipitation from July through September. Summer high temperatures regularly exceed 90 °F in the river valleys, such that mid-July through August is generally the critical period for stream high temperatures.

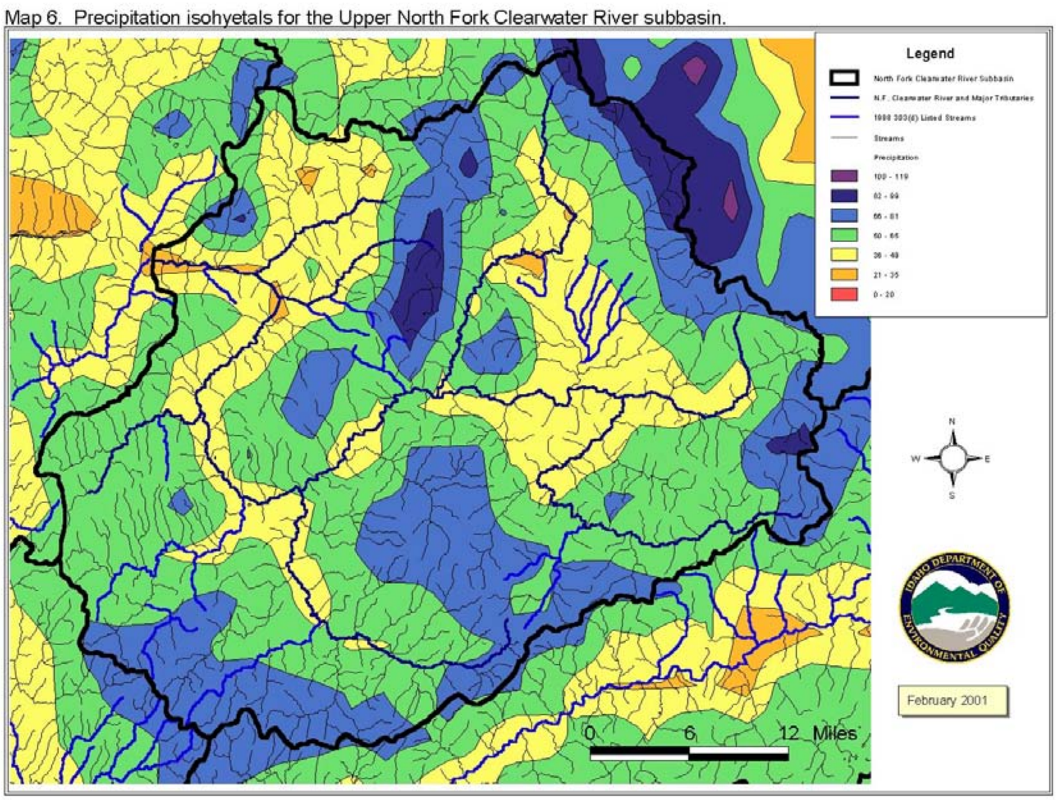

Figure 2. Precipitation Zones of the UNFCRS

Data from three weather stations (located at Powell, Fenn, and Pierce) and six snow telemetry (SNOTEL) stations (SNOTEL Website) are presented in Table 1. Powell, located on the Lochsa River at an elevation of 3,409 feet, is considered representative of mid-elevation canyon sites at the upper end of the UNFCRS with a strong continental influence. Fenn, on the Selway River at 1,480 feet elevation, is considered representative of the lower canyon lands (e.g., around Canyon Ranger Station) with a strong maritime influence. Pierce, located at 3,079 feet elevation, represents mid-elevation upland sites on the western, more maritime influenced side of the subbasin. The SNOTEL data from Shanghai Summit, Hemlock Butte, and Elk Butte reflect high elevation conditions on the western edge of the basin, while those from Cool Creek, Crater Meadows, and Lolo Pass reflect high elevation conditions on the eastern end of the basin.

Table 1. Weather data from selected stations in and around the UNFCRS.

Type[1]	Station Name	Elevation (feet)	Latitude	Longitude	Record Dates	Mean Annual Temperature (°F)	Average Monthly Temperature (°F)	Mean Annual Precipitation (inches)	Average Number of Days Above 90 °F per Year[2]
NWS	Fenn	1480	46.00	115.55	1948 to pres.	49.2	48.9	38.03	32.0*
NWS	Pierce	3079	46.50	115.80	1963 to pres.	42.2	42.2	41.38	15.1***
NWS	Powell	3409	46.52	114.70	1962 to pres.	42.7	42.6	39.59	10.6**
SNOTEL	Shangai Summit	4600	46.32	115.45	1993 to 1999	39.5	40.6	56.08	6.25
SNOTEL	Lolo Pass	5240	46.38	114.35	1993 to pres.	34.7	35.9	48.88	1.67
SNOTEL	Elk Butte	5420	46.50	116.07	1993 to pres.	36.8	38.1	60.89	0
SNOTEL	Hemlock Butte	5810	46.29	115.38	1993 to pres.	37.0	38.3	70.21	0
SNOTEL	Crater Meadows	5960	46.34	115.17	1993 to 1999	34.9	35.7	67.84*	0
SNOTEL	Cool Creek	6280	46.46	115.18	1993 to pres.	35.7	36.7	72.96*	0

[1]NWS = National Weather Service station (National Climatic Data Center Website) SNOTEL = Snow Telemetry station (SNOTEL Website)
[2] Years of Record: * 1983 – 1999 ** 1993 – 1997 *** 1990 - 2000

Appendix 2, Figures 2-1 through 2-8 show the average monthly means, maximums, and minimums for temperature and precipitation for Powell, Fenn, Pierce, and Hemlock Butte. Looking at the temperature and precipitation patterns, one can immediately see that the months with the highest temperatures are also those with the lowest precipitation, and vice versa. (Note that the y-axis scales are not the same on all the figures.)

For the period of record, Powell's and Pierce's mean annual temperatures were very similar (42.7 °F and 42.2 °F, respectively). However, the mean annual temperature at Fenn, located at a much lower elevation, was 49.2 °F. The subbasin temperatures ranged from mean January minimums of approximately 23.3 °F, 15.6 °F, 15.9 °F, and 7.1 °F to mean July/August maximums of approximately 88.5 °F, 82.4 °F, 80.9 °F, and 72.1 °F at the Fenn, Powell, Pierce, and Hemlock Butte stations, respectively.

Hot summer temperatures occur regularly in the subbasin and are a major factor influencing stream temperatures. Table 1 summarizes the number of days with temperatures above 90 °F at each of the weather stations. At Pierce and Powell, temperatures of greater than 90 °F occur on about 15 to 25 percent of the July and August days. On average, the Fenn station exceeds 90 °F on about 50 percent of the July and August days. As a point of reference, since water temperatures over time equilibrate to air temperatures, note that at Fenn the average monthly air temperature exceeds Idaho's 13 °C (55.4 °F) salmonid spawning instantaneous water temperature criterion from May through September. Thus it might be expected that water temperatures naturally exceed the state's numeric criteria.

Precipitation at Fenn has averaged 38 inches annually, with 53 inches of snowfall. Annual precipitation at Powell averages about an inch more, but with cooler temperatures, snowfall more than triples to 178 inches. About 45 percent of the annual precipitation falls as snow at Powell. At the Fenn station, only 14 percent of the annual total comes as snow; even in the winter most of the precipitation is rain. Figures 2-2, 2-4, 2-6, and 2-8 in Appendix 2 show that the maximum precipitation at all sites occurs during the winter.

Precipitation increases markedly with elevation in the mountains. Higher peaks, especially in the northeast corner of the subbasin, may receive as much as 100 inches per year, making them among the wettest of any areas in Idaho (NRCS website). The winter snowpack is vital to sustaining summer flows in the subbasin.

Occasionally, mild Pacific air masses meet cold continental air masses producing heavy rainfall combined with rapid snowmelt: this phenomenon is called a rain-on-snow event. These events often occur mid-winter, outside the normal spring snowmelt. They lead to soil saturation and huge amounts of runoff and can produce large amounts of sediment through erosion and mass wasting. Low to mid elevations, up to about 4,000 feet elevation, are the most susceptible to rain-on-snow events in the subbasin, since above 4,000 feet it is cold enough that most of the precipitation still falls as snow. Two major rain-on-snow events have occurred in recent history – one in the winter of 1975-76 and the other in winter of 1995-96. Both events caused flooding and landslides in UNFCRS below about 4,000 feet (McClelland et al. 1997). These events are likely the most significant contributors of sediment to the water bodies in the UNFCRS. While these are natural climatic events, the question that needs to be answered is to what degree human activity, especially road building, exacerbates the effects of these events on the landscape.

Subbasin Characteristics

This section summarizes the area's hydrology, geomorphology, geology, soils, climate, and landscape hazards with emphasis on how these characteristics relate to sediment and temperature, the pollutants of concern in the subbasin.

Hydrology

The UNFCRS, the main river, major tributaries, 303(d) listed stream segments, and surrounding hydrologic features are shown in Figure 3.

The UNFCR flows almost 74 miles from its headwaters to where it empties into Dworshak Reservoir. The USGS calculates the mean annual flow for the UNFCR from 1967 to present at its Canyon Ranger Station just upstream from the reservoir to be 3,511 cubic feet per second (Brennan et al. 1999). Figures 2-9 and2-10 in Appendix 2 show flow for 1998-99, mean daily flow for the period of record, and the daily flow for the period of record. Flow has ranged from a daily mean of 34,200 cubic feet per second on November 30, 1995, to 252 cubic feet per second on December 5, 1972. Peak flows generally occurred during spring run-off between April 18 and June 17 for the period of record, with May 23 as the median date for peak flow. The extreme peak flows shown in Appendix 2, Figure 2-10, represent rain-on-snow events. Low flows occur from August through mid- to late-winter. Low flows in late July and August, when air temperatures are high, can lead to high water temperatures.

Figures 2-11 through 2-15 in Appendix 2 show flow data collected by the CNF for five watersheds in the UNFCRS – the North Fork at Kelly Creek, Cold Springs Creek, Swamp Creek, Quartz Creek, and Gravey Creek. Since each site only has a few years of record, we have selected specific years to plot that show normal and extreme flows. Years 1983 and 1984 have records at the most sites. The same general trend can be seen in this data as in the USGS data. High runoff occurs from late April through early June, with some mid-winter peaks representing rain-on-snow events. Low flow begins in late July and August and continues on into late winter.

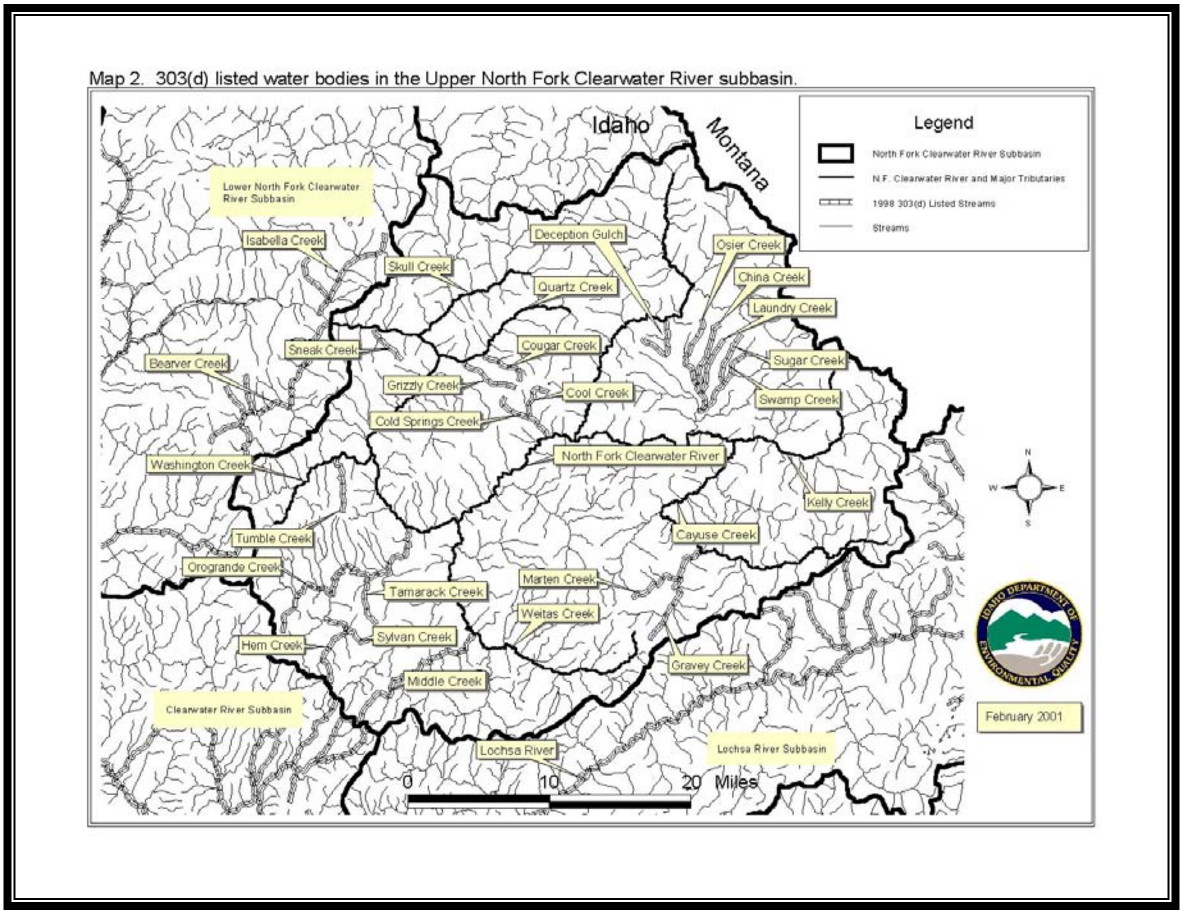

Figure 3. Major Hydrologic Features and 303(d) Listed Stream Segments of the UNFCRS Area

Geomorphology

The UNFCRS is a mature, deeply dissected upland forming part of the Clearwater Mountains of the Bitterroot Range in the northern Rocky Mountains. Elevations range from about 1,660 feet at the USGS gauging station near the Canyon Work Station to nearly 8,000 feet on Rhodes Peak on the Bitterroot Divide. The southern, eastern, and northern boundaries of the watershed, as well as the divide between Kelly Creek and the North Fork above Black Canyon, generally have elevations of 5,000 feet or more.

The CNF utilizes a land classification system that categorizes the landscape into landform units. Table 2 lists the various landform types and their percentages within the subbasin (USFS 1999b), and Figure 4 shows their distribution.

Table 2. Landform types within the UNFCRS.

Landform Type	Percentage
Valley bottoms and recent alluvium	0.2
Breaklands (>60% slopes)	28.3
Alpine glaciated ridges, headlands, and troughs	8.4
Colluvial midslopes (generally 30 - 60% slopes)	15.2
Frost-churned ridges (moderate slopes)	26.7
Low relief hills (<30% slopes)	19.9
Mass wasted areas	1.3

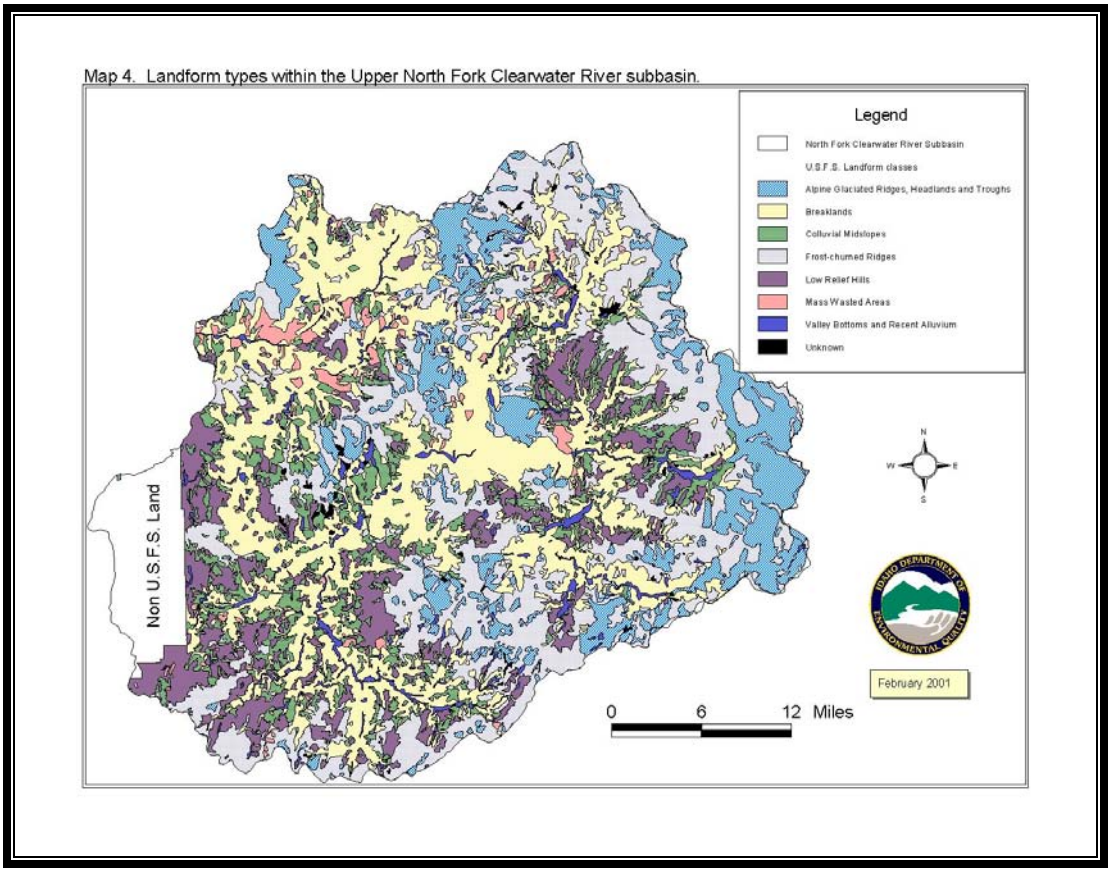

Figure 4. Landform Types of the UNFCRS

Alpine glaciation created some broad U-shaped valleys and extensive alpine meadows in the upper reaches of many drainages. Middle elevations in the Clearwater Mountains are characterized by more gentle terrain with broadly rounded ridges as result of frost churning. Lower elevations display deeply dissected breaklands with oversteepened slopes that are susceptible to erosion and mass failure. The abundance of breaklands (28% of the landscape) suggests the UNFCR is rapidly (in geologic time) entrenching its bed (Alt and Hyndman 1989). The angulate stream pattern suggests joint and/or fault control. Exploitation of more erosive rock along the contact zone between different bedrock types (see geology discussion below) may be one reason for the UNFCR's rapid incision and landscape oversteepening. A little over one percent of the total area is mass wasted, which is a concern for water quality.

In addition to the general landform types, the CNF has developed a detailed classification of the various landforms based on their bedrock and soils and the vegetation they support (Wilson et al. 1983), resulting in several hundred "landtypes" being identified in the CNF. Many of the CNF's management decisions and hazard ratings are based on the landtypes. Much of the CNF data presented below in this report is related to landtypes.

Geology

The general surface geology is represented in Figure 5 (derived from Lewis et al. 1992). The mapped geology for the subbasin does not correlate well with the geology described for many of the landtypes. Much of this is because the landtypes were mapped before the geology was well understood and mapped in the UNFCRS. Reed Lewis (personal communication 2000) confirms that he recognized this situation while mapping the subbasin in the late 1980s and paid particular attention to confirming his bedrock mapping in areas that disagree with the landtype mapping. In the summary assessments for each water body in Chapter 5 of this report, the reader may note discrepancies between the geology described for the landtypes and that described as the mapped geology. Our field work confirms that the mapped geology is likely correct.

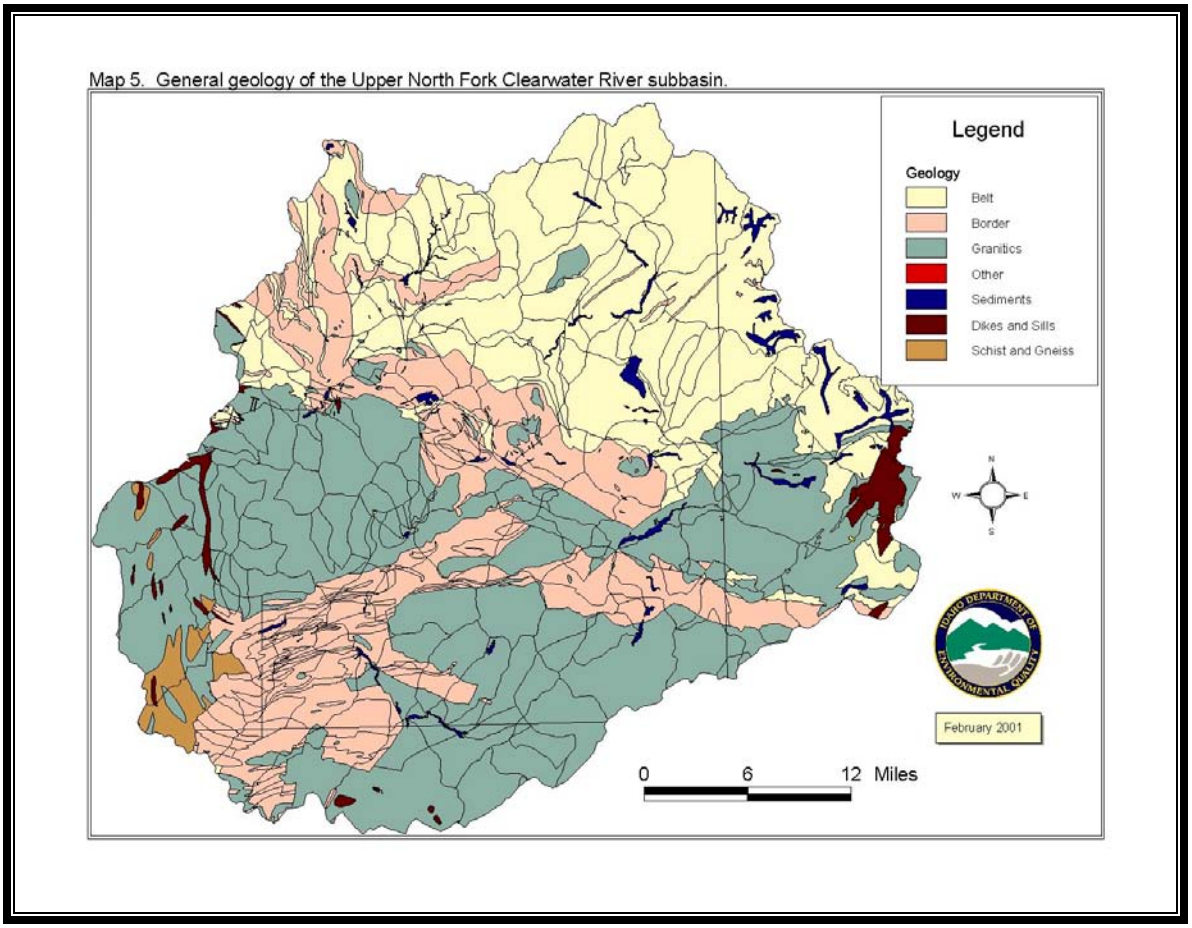

Figure 5. General Geology of the UNFCRS

The subbasin is located on the northern edge of the Idaho Batholith. Upper Jurassic to Cretaceous age plutonic rocks intrude and are bordered by Precambrian-aged metasedimentary rocks. The intrusive igneous rocks of granitic to granodioritic composition are the dominant lithology in the southern half of the subbasin. They are generally considered to be associated with the Idaho Batholith, which underlies most of central Idaho (Alt and Hyndman 1989), although they are highly altered and variable on this extreme edge of the batholith. The north-northeast portion of the subbasin is dominated by Precambrian-aged Belt Supergroup interlaminated metasediments ranging from argillite to quartzite.

Running in a southeast to northwest direction is a contact zone between plutonic and metasedimentary rocks that has resulted in high grade metamorphic schist and gneiss. Another zone of highly metamorphosed schist and gneiss occurs in the southwest of the subbasin. These contact zones have been called "border zones" or the "western Idaho suture zones." The border zone schist and gneiss areas of the subbasin are highly variable in rock structure and composition. The mixed and highly variable nature of the contact zone between the metasedimentary and granitic lithologies exhibits considerable structural and weathering variability and results in an associated high mass failure hazard.

Of particular interest is a body of Tertiary-aged deposits in the Moose Creek and adjacent watersheds. These deposits have been the object of extensive placer mining in the past and are susceptible to erosion. Their presence leads to speculation that these particular surfaces have been exposed to weathering for a long period of time such that bedrock in the vicinity is deeply weathered, incompetent, and relatively erodible.

Soils

The granodiorite that underlies the southern portion of the subbasin weathers rapidly to grus, a sandy material with the structure of the original rock. The soils derived from the grus tend to be sandy, excessively well drained, and cohesionless. The metasediments that occur in the northern part of the subbasin generally weather to finer textured soils with varying amounts of coarse fragments. Quartzite tends to weather to the coarsest texture, with large amounts of coarse fragments. Siltite and argillite weather to finer textured soils with fewer coarse fragments. Soil depth tends to decrease and the amount of coarse fragments tends to increase on steeper and more convex slopes. Soils derived from bedrock in the suture zone are highly variable, reflecting the complexity of the bedrock. Soils derived from the Tertiary sediments tend to be fine-textured and fairly dense. When exposed during road building or other earth disturbing practices, these soils are highly erodible and difficult to stabilize.

Most soils include a layer of Mazama volcanic ash up to 20 inches thick on the surface. This layer of volcanic ash contributes substantially to the water and nutrient holding capacity of the soils and is the primary reason for the high productivity and stability of the soils in the UNFCRS. The volcanic ash has been eroded away in places, primarily on very steep south to west facing slopes and in areas seriously denuded by fire.

Terrestrial Vegetation

The subbasin is dominated by coniferous forest vegetation. Western red cedar (*Thuja plicata*), Douglas fir (*Pseudotsuga menziesii*), and grand fir (*Abies grandis*) are common tree species. Other tree species of commercial value are western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), western hemlock (*Tsuga hetophylla*), western larch (*Larix occidentales*), and Englemann spruce (*Picea Englemanii*). Higher elevation subalpine zones are dominated by Englemann spruce, subalpine fir (*Abies lasiocarpa*), and mountain hemlock (*Tsuga mertensiana*). Alder (*Alnus* spp), birch (*Betula* spp), cottonwoods (*Populus* spp), and mixed forbes and shrubs have reforested some areas subjected to severe forest fires. The subbasin contains some of the most productive tree growing sites in north Idaho.

The forests in the UNFCRS are thought to contain some 1,200 to 1,500 plant species, only a few of which are trees. The forest understory in the UNFCRS ranges from nearly pure grasslands to nearly pure shrublands, with all gradations in between. More interestingly, the understory vegetation communities range from very drought tolerant (primarily grasslands), to communities associated with mild, moist Pacific maritime climates. These more maritime communities are dominated by evergreen species when protected by cedar and hemlock tree canopies. Many logging and other events that remove the tree canopy often result in dense stands of shrubby species with diverse composition crowding these productive sites.

Vegetation of the subbasin has been significantly altered since 1900. White pine blister rust largely eliminated stands dominated by western white pine. The CNF estimates that western white pine as a cover type has been reduced from being the dominant type in the subbasin in the early 20th century to less than two percent today. The large fires of 1910, 1919, and 1934 significantly reduced the tree canopy in the subbasin. These, coupled with the fire suppression and logging practices, have changed the forest composition from being dominated by long-lived, shade-intolerant species to forests dominated by short-lived, shade-tolerant species.

Forest fires have affected the distribution and types of vegetation. For example, forest fire history records show that large fires in 1910, 1919, and 1934 burned major portions of the subbasin. Because some drainages burned two or three times between 1910 and 1934, forest succession there has been retarded and seral shrub fields still dominate (USFS 1997). The CNF estimates that 63 percent of the entire subbasin has been burned since the 1910 fire (USFS 1999b).

Similarly, logging and road building over the last half century have significantly altered the forests. In a 1999 report of 14 selected watersheds in the UNFCRS, the CNF identified equivalent clearcut acres ranging from two to 15 percent, meaning that that the percentage of the canopy in those watersheds had been reduced by that amount (USFS 1999a). It is probable that the equivalent clearcut acres for many of the watersheds being considered in this assessment is greater than 15 percent. In addition, logging has changed the species composition of the forest, as noted above.

Aquatic Life

The following game fish may be found in the subbasin:

Common Name	Taxonomic Nomenclature
Brook trout	(*Salvelinus fontinalis*)
Bull trout	(*Salvelinus confluentus*)
Golden trout	(*Oncorhynchus aguabonita*)
Mountain whitefish	(*Prosopium williamsoni*)

Rainbow trout	(*Oncorhynchus mykiss*)
Steelhead	(*Oncorhynchus mykiss*)
Kokanee salmon	(*Oncorhynchus nerka*)
Westslope cutthroat trout	(*Oncorhynchus clarki lewisi*)

The following non-game fish species may be found in the subbasin:

Common Name	Taxonomic Nomenclature
Mottled sculpin	(*Cottus bairdi*)
Paiute sculpin	(*Cottus beldingi*)
Shorthead sculpin	(*Cottus confusus*)
Torrent sculpin	(*Cottus rhotheus*)
Redside shiner	(*Richardsonius balteatus*)
Longnose dace	(*Rhinichthys cataractae*)
Speckled dace	(*Rhinichthys osculus*)
Largescale sucker	(*Catostomus macrocheilus*)
Bridgelip sucker	(*Catostomus columbianus*)
Mountain whitefish	(*Prosopium williamsoni*)
Chiselmouth	(*Acrocheilus alutaceus*)

The UNFCR drainage currently has two fish populations that are species of concern – bull trout and westslope cutthroat trout. Bull trout were listed as a threatened species within the Columbia River Basin under the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS) on July 10, 1998.

Bull trout populations are currently considered depressed in most of the tributaries within the UNFCR drainage. Focal populations occur in the Upper North Fork Clearwater River, North Fork Kelly Creek, Meadow Creek, Vanderbilt Creek, Lake Creek, Long Creek, Hidden Creek, Elizabeth Creek, Skull Creek, upper Quartz Creek, Johnny Creek, upper Weitas Creek, Fourth of July Creek, Cayuse Creek, and upper Kelly Creek above Cayuse Creek (USFS 1999b).

Westslope cutthroat trout were recently proposed to be listed under the Endangered Species Act; however, the USFWS decided not to list the species at this time. Fish data show cutthroat trout populations are present in most drainages of the UNFCRS. The UNFCRS is considered to support one of the last strong westslope cutthroat trout populations in Idaho. The CNF determined that 23 out of 54 subwatersheds showed strong populations, 11 showed depressed populations, 14 had populations of unknown strength, and data were unavailable for 6. Overall, the CNF concluded that populations are well-distributed and in strong condition in 36 of the 54 subwatersheds (USFS 1999b).

Several varieties of herptofauna are known or suspected to inhabit the subbasin, including the long-toed salamander, Coeur d'Alene salamander, Idaho giant salamander, tiger salamander, garter snake, western toad, Pacific chorus frog, bull frog, and tailed frog (Clearwater Basin Bull Trout Technical Advisory Team 1998).

The macroinvertebrate assemblage includes Ephemeroptera, Plectoptera, Trichoptera, Coleoptera, and Diptera. The 1996 BURP data suggest that most of the macroinvertebrates sampled basin-wide are Ephemeroptera, Plectoptera, and Trichoptera (DEQ 1996). These genera are generally indicators of good water quality.

Landscape Hazards to Water Quality

Mass Failures: Landslides, debris avalanches, and other forms of mass wasting are the dominant erosional processes in the subbasin (USFS 1999b). Landslides are natural events across much of this landscape, but the risk has increased due to road construction and timber harvest over the past 40 years. Some 370 landslides were reported in the watershed resulting from the storm events in the winter of 1995-1996, with the majority initiated from forest roads. Using the CNF's landtype hazards ratings, approximately 30 percent of the total subbasin acreage has a high or very high mass failure hazard rating (Figure 6), and about 13 percent of the area has a high debris avalanche hazard rating.

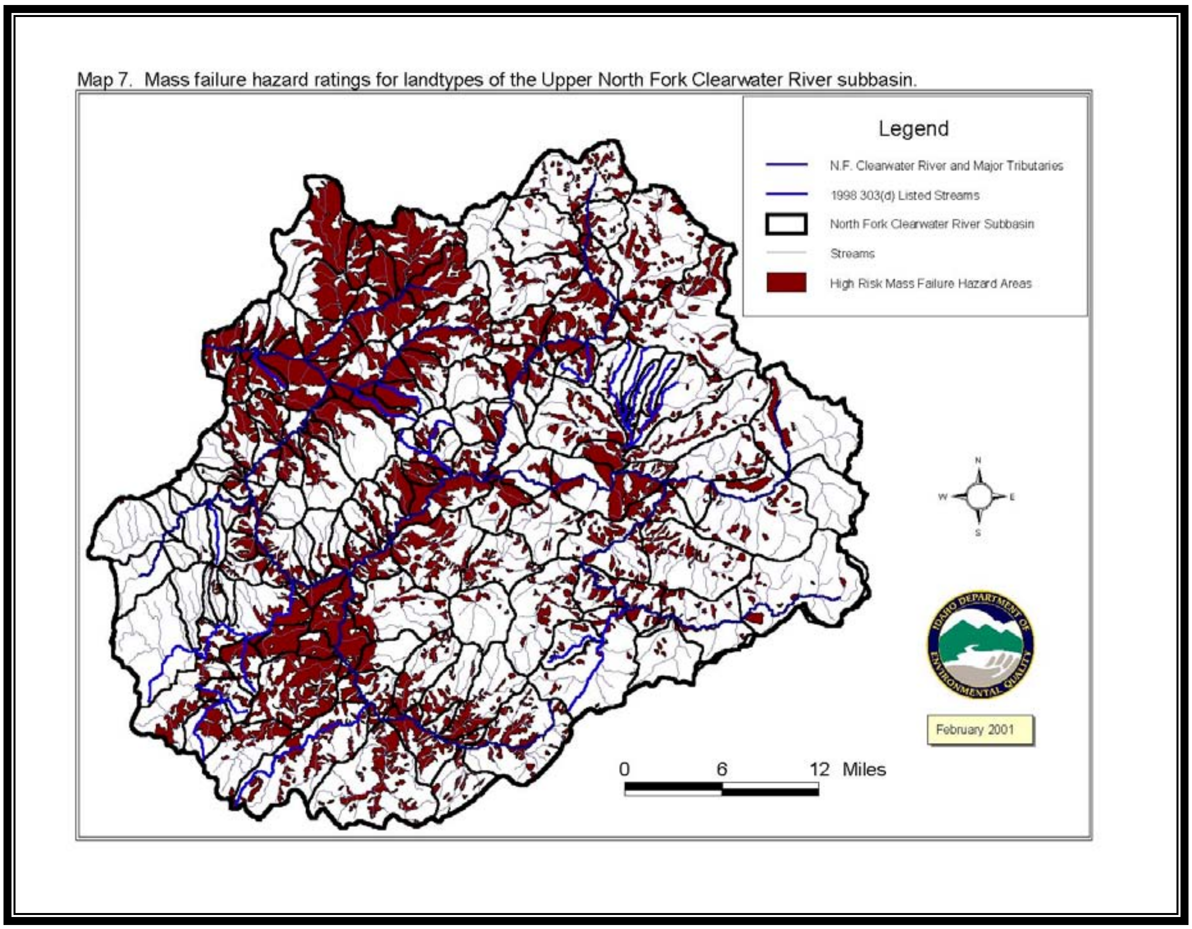

Figure 6. High Mass Failure Hazard Areas of the UNFCRS

Surface Erosion: About 20 percent of the UNFCRS watershed has a high surface erosion hazard rating. High surface erosion landtypes tend to be on south- to west-facing steep slopes that have for one reason or another lost their surface layer of volcanic ash. Surface erosion has, in fact, occurred on many steep landforms in the UNFCRS since historic times, particularly after wildfires (USFS 1999b).

Subsurface Erosion Hazard: Idaho's CWE process identifies erosion from roads as one of the major sources of sediment being delivered to water bodies (IDL 2000). In most cases, significant road erosion occurs where road prism construction removes the topsoil and sediment-retaining roots, exposing subsoils with little structure or internal coherence. Approximately six percent of the subbasin is classified as having a high subsurface erosion hazard.

In-Stream Erosion Hazard: Current stream conditions are largely a function of channel gradient and stream energy (i.e., the stream's ability to move sediment). When bed material is cobble-size and smaller, stability decreases, and the channels react quickly to changes in sediment and flow regime. Lower gradient channels have a higher sensitivity to sediment input, with less transport capacity. Disturbances in a low-gradient stream channel with a fine sediment or an erodible geologic material bed and bank system can easily lead to in-stream erosion. Very few sensitive stream systems occur in the UNFCRS. Known streams with relatively high sensitivity occur in the Orogrande Creek and Moose Creek watersheds – areas of old surfaces exposed to weathering.

Nearly 80 percent of the streams in the subbasin are first- and second-order, steep, Rosgen (1994) A-type channels, which are predominantly stable when the streambed material is bedrock or boulder. Some of the watersheds in the UNFCRS have high road densities and have been intensively managed, yet are resilient and capable of handling large amounts of sediment without adverse impacts to their hydrologic integrity (USFS 1999b).

Channel form and function, although variable across the subbasin, are for the most part stable and within dynamic equilibrium. Notable exceptions are heavily roaded and harvested watersheds that suffered numerous landslides and road failures during the 1975-76 and 1995-96 rain-on-snow events. In particular, the colluvial midslopes contain over 50% of the sensitive channel types in the UNFCRS, yet comprise only 15 percent of the area (USFS 1999b).

The majority of the 303(d) listed stream segments being addressed in this subbasin assessment have lower gradient, Rosgen (1994) B type channels, which have an intermediate in-stream erosion hazard. The fact that the 303(d) listed streams have lower gradients than average in the UNFCRS probably reflects the fact that historic logging activities have centered on the more gentle terrain. Additional information about stream characteristics of the 303(d) listed streams in the subbasin can be found in Chapter 2.

Fire Hazard: The hazards to water quality of a burned landscape are two-fold: the denuded landscape is more susceptible to erosion and the denuded stream banks increase heat loading/stream temperatures. Areas with higher hazards for fire tend to be south- to west-facing slopes. The fact that many of these slopes no longer have a surface layer of volcanic ash probably reflects the fact that these slopes have burned several times in the last 8,000 years. Slopes lower in the canyons with lower effective precipitation are most susceptible to fire. These slopes are more susceptible to drought, and thus to fire; therefore, increasing their erosion potential which starts a negative cycle of fire and erosion. The CNF data indicate that about 15 percent of the subbasin has strong south- to west-facing slopes with high fire frequencies of 26 to 100 years (USFS 1999b).

Removal by fire of the coniferous canopy that shades streams often leads to significant, long-term effects on stream temperatures. Large, catastrophic fires are the most likely to destroy streamside vegetation. Once the tall tree canopy is removed, it may require centuries for trees to reestablish in swampy and cold-air-drainage areas. Smaller, shrubby species do not provide the same quality of shade and environmental buffering. Further, the destruction of large trees removes potential large woody debris and its consequent stream structure. Other areas with higher than expected fire hazards are those adjacent to and associated with human activities. For the most part, these correlate fairly well to roaded areas of the subbasin.

1.3 Cultural Characteristics

This section describes present land ownership and principal land uses in the UNFCRS.

Land Ownership

The UNFCRS is predominantly owned by the federal government and managed by the CNF. The state of Idaho, Potlatch Corporation, and private individuals also own small portions of the UNFCRS (Figure 1).

Total Subbasin Acreage	**828,460 Acres**
U.S. federal lands managed by CNF	787,133
Potlatch Corporation	29,792
State of Idaho	10,208
Other private holdings	680
Open water	647

Land Use

The UNFCRS is largely a forested landscape dominated by forestry and associated recreational activities.

Native American Traditional Uses

The Nez Perce people have been residents in the study area for over 8,000 years. The UNFCRS is within the Nez Perce Tribe's ceded territories. The Treaty of 1855 reserved fishing and hunting rights in these areas, and it established a responsibility for the management of fish and wildlife resources. The Nez Perce Tribe's treaty-reserved interest in maintaining and utilizing natural resources is important to its sense of community. The fishery and the waters supporting it are revered by the Nez Perce for the life and sustenance these resources have given and continue to provide to tribal members.

Forestry

Logging began in the UNFCRS in 1935 with western white pine salvage logging and logging of western red cedar for power poles. Initially, log flumes were built down major drainages to the North Fork River. From there, logs were floated to Lewiston in the now historic Clearwater River log drives. Subsequently, logging systems utilized railroads, tractors/bulldozers, Idaho jammers with a maximum of 800-foot road spacing, skylines with longer cable reaches, and, most recently, helicopters. Logging activity and the associated road construction was at its greatest in the 1960s and 1970s, and has tapered off considerably since (Table 3). According to CNF stand data, about 10 percent of the subbasin has been logged. Figure 7 shows the harvested areas of the UNFCRS.

Table 3. Timber harvested by decade in millions of board feet from CNF land.

Decade	Millions of Board Feet Harvested
1930s	40
1940s	51
1950s	173
1960s	726
1970s	694
1980s	318
1990s	228

Logging still plays an important role in the economies of the communities surrounding the subbasin (USFS 1999a), including Orofino, Pierce, Weippe, Kamiah, Headquarters, Cardiff, and Lewiston, Idaho; and Superior, Montana.

Mining

Mining in the subbasin began in the last half of the 19th century and has continued to the present, with the amount of activity varying greatly over time. The majority of the mining has been placer mining occurring in the streams and stream valleys. Some upland mining for precious metals occurred in the late 1800s in Cayuse and Kelly Creeks. Aggregate mining, primarily for road construction, continues to the present, and is usually located on uplands away from the streams and riparian areas.

Habitat conditions within most of the Orogrande Creek, Moose Creek, and upper North Fork drainages have most likely improved substantially since the gold mining era of the 1860s through the early 1900s. The majority of these streams and most, if not all, of their tributaries were placer-mined by hand, dredge, and large machinery. Riparian areas and stream channels were probably altered numerous times (USFS 1999b).

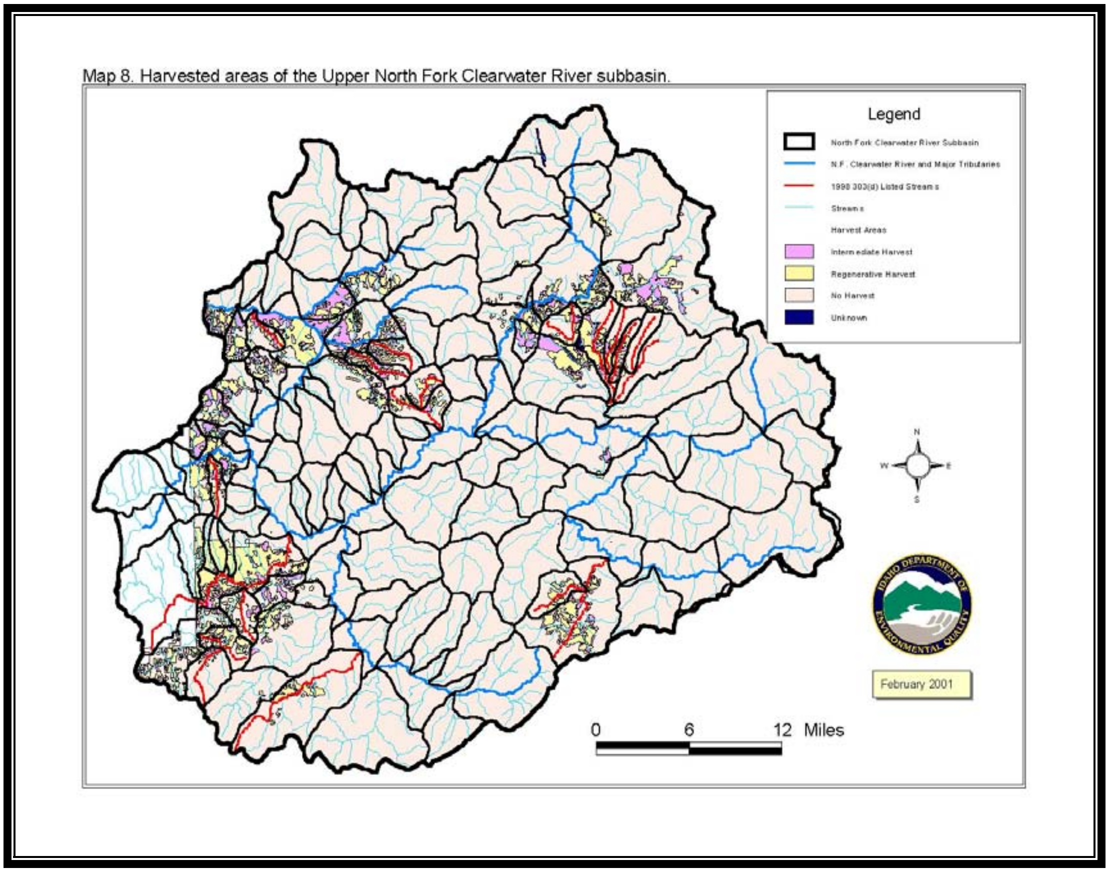

Figure 7. Timber Harvested Areas in Relation to the 303(d) Listed Streams

Currently, there are approximately 16 registered recreational suction dredges in the basin that operate during the summer, primarily in the Moose and Orogrande watersheds. There are six patented mining claims in the Moose and Bostonian Creek watersheds. There are 15 additional unpatented placer mining claims within the basin. The total recorded production in the North Fork of the Clearwater in 1990 was estimated to be 197 ounces of gold and 44 ounces of silver (U.S. Bureau of Mines et al. 1993).

Grazing

Grazing allotments were established in Cayuse and Kelly Creeks in the early 1900s following a series of wildfires that reduced the tree canopy cover and allowed considerable undergrowth. Large numbers of sheep were grazed until natural succession reduced the understory, making grazing infeasible. Currently, grazing on the CNF land is limited to pack animals and saddle stock. On state and private land in Orogrande Creek, limited grazing is permitted after timber harvest.

Recreation

Recreational activities include fishing, kayaking, canoeing, rafting, swimming, hunting, camping, mountain biking, wildlife and scenery viewing, skiing, trapping, 4-wheeling, motorcycling, hiking, and driving the historic trail systems. Some of these activities also provide economic benefits. The CNF maintains several campgrounds along the main stem rivers in the area.

The Lolo trail system attracts visitors who are interested in its prehistoric and historic trails. The trail known to the Nez Perce as *Kushahna Ishkit*, the buffalo trail, is potentially thousands of years old. The Lolo Motorway generally follows the Nez Perce *Nee-Me-Poo* trail, which was used by the Nez Perce in their 1877 flight from their homelands eastward into Montana. Lewis and Clark's trail through the region is marked as well.

Transportation

The CNF GIS roads layer identifies 1,951 miles of roads in the 1,294 square mile subbasin, yielding an average road density of 1.6 road miles per square mile. Major drainages affected by road construction include Washington, Orogrande, Quartz, Cold Springs, and Moose Creeks (Figure 8) (USFS 1999b). Of particular interest to water quality issues are those roads that are close to streams. There are 352 miles of roads (18% of total roads) in the UNFCRS within 100 feet of a mapped waterway.

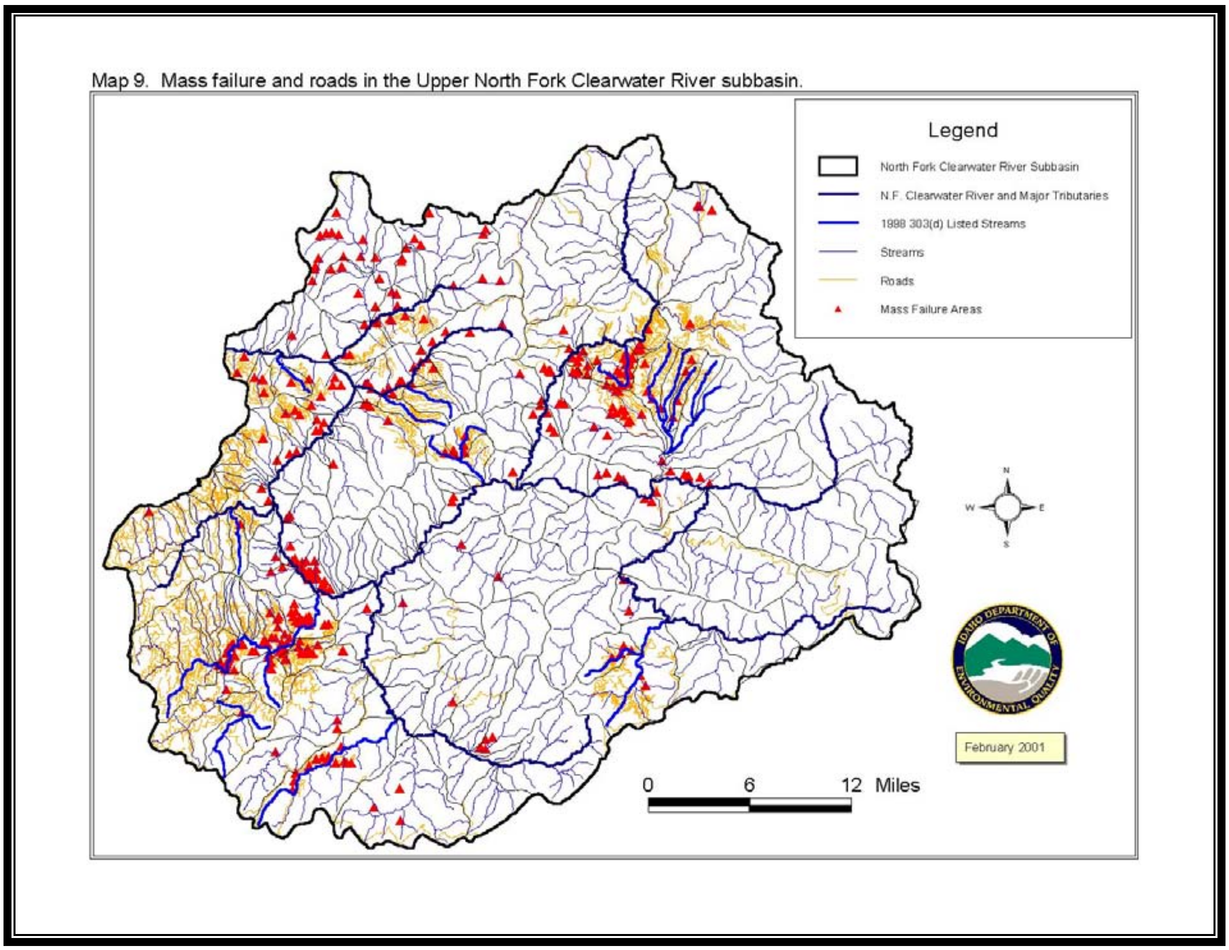

Figure 8. Roaded Areas of the UNFCRS